TABLE I.—*Hourly observations at the Observatory, San Jose de Costa Rica, during January*, 1901.

Hours.	Pressure.		Temperature.		Relative humidity.		Rainfall.		
	Observed, 1901.	Normal, 1889-1900.	Observed, 1901.	Normal, 1889-1900.	Observed, 1901.	Normal, 1889-1900.	Observed, 1901.	Normal, 1889-1900.	During 1901.
	660+ mm.	660+ mm.	° C.	° C.	%	%	Mm.	Mm.	Hrs.
1 a.m.	4.47	3.71	16.25	16.25	80	85	0.9	0.1	1.00
2 a.m.	3.95	3.33	16.21	16.04	82	85	0.4	0.0	0.83
3 a.m.	3.63	3.14	16.15	15.84	82	86	0.0	0.1	0.00
4 a.m.	3.65	3.19	16.00	15.71	83	86	0.0	0.2	0.00
5 a.m.	3.83	3.41	15.95	15.56	84	86	0.0	0.3	0.00
6 a.m.	4.06	3.71	15.84	15.50	86	85	0.0	0.2	0.00
7 a.m.	4.53	4.14	16.63	15.89	80	83	0.0	0.4	0.00
8 a.m.	4.91	4.52	18.29	18.24	71	76	0.0	0.3	0.00
9 a.m.	5.20	4.73	20.45	20.20	63	70	0.2	0.4	0.08
10 a.m.	5.20	4.67	22.18	22.02	61	65	0.0	0.0	0.00
11 a.m.	4.95	4.34	23.32	22.95	59	63	0.0	0.0	0.00
12 a.m.	4.53	3.85	24.08	23.49	58	61	0.0	0.1	0.00
1 p.m.	3.71	3.24	24.42	23.86	55	61	0.0	0.3	0.00
2 p.m.	3.17	2.71	24.27	23.59	58	63	0.1	0.2	0.50
3 p.m.	2.99	2.46	23.46	23.05	61	65	0.1	0.5	0.33
4 p.m.	3.07	2.48	22.48	21.82	64	67	0.0	2.0	0.00
5 p.m.	3.34	2.68	20.50	20.31	70	73	0.3	2.9	1.00
6 p.m.	3.73	2.99	19.13	18.92	75	77	0.6	0.9	1.00
7 p.m.	4.19	3.58	18.38	18.08	77	81	0.3	0.1	1.00
8 p.m.	4.79	3.95	18.01	17.73	77	82	0.4	1.2	1.00
9 p.m.	5.21	4.26	17.61	17.37	77	83	0.3	0.1	1.00
10 p.m.	5.39	4.45	17.31	16.98	77	84	0.0	0.6	1.00
11 p.m.	5.26	4.30	16.95	16.71	78	85	0.1	0.4	1.00
12 p.m.	5.01	4.08	16.58	16.45	80	85	0.2	0.1	1.00
Mean	664.29	663.66	19.19	18.88	73	77	.....	.....	.....
Minimum	661.3	660.04	10.7	9.8	.....	.....	.....	.....	.....
Maximum	667.0	668.12	31.2	30.3	.....	.....	0.9	2.9	.....
Total	.....	.....	.....	.....	.....	.....	3.9	11.8	10.74

REMARKS.—The barometer is 1,169 meters above sea level. Readings are corrected for gravity, temperature, and instrumental error. The dry and wet bulb thermometers are 1.5 meters above ground and corrected for instrumental errors. The hourly readings for pressure, wet and dry bulb thermometers are obtained by means of Richard registering instruments, checked by direct observations every three hours from 7 a. m. to 10 p. m. The hourly rainfall is as given by Hottinger's self-register, checked once a day.

TABLE 2.

Time.	Sunshine.		Cloudiness	Temperature of the soil at depth of—				
	Observed, 1901.	Normal, 1889-1900.	Observed, 1901.	0.15 m.	0.30 m.	0.60 m.	1.20 m.	3.00 m.
	Hours.	Hours.	Per cent.	° C.	° C.	° C.	° C.	° C.
7 a.m.	4.46	8.28	34	19.45	19.83	20.05	20.26	20.87
8 a.m.	22.58	22.43						
9 a.m.	22.48	22.55						
10 a.m.	19.51	20.73	42	19.71	19.87	20.07	20.28	.....
11 a.m.	18.59	19.74						
12 m.	17.47	18.42						
1 p.m.	18.00	17.99	45	20.38	20.05	20.07	20.31	.....
2 p.m.	19.32	19.74						
3 p.m.	17.91	19.23						
4 p.m.	19.05	17.44	54	20.00	19 57	20.12	20.32	.....
5 p.m.	15.48	12.70						
6 p.m.	2.70	2.54						
7 p.m.	.....	.....	34	20.48	20.22	20.03	20.26	.....
8 p.m.	.....	.....						
9 p.m.	.....	.....						
10 p.m.	.....	.....	29	19.97	19.93	19.97	20.20	.....
11 p.m.	.....	.....						
12 p.m.	.....	.....						
Mean	.....	.....	40	20.00	19.61	20.05	20.27	20.87
Total	197.55	201.79	.....	.....	.....	.....	.....	.....

Notes on the weather.—January 18–19, stormy days with strong east wind, high barometer and rain in San Jose; violent rainfall on the Atlantic slope with inundations and damage to the railroad.

Notes on earthquakes.—January 1, 6:57 and 7 p. m., two slight undulatory tremors from northwest to southeast; intensity, 4; duration, 5 seconds. January 7, 4:41 a. m., one slight undulatory movement, east-northeast to west-southwest, intensity 2, duration 3 seconds—6:27 p. m.; slight tremor north-northwest, intensity 4, duration 8 seconds—11 p. m., very slight trepidatory movement, intensity 1, duration 2 seconds.

TABLE 3.—*Rainfall at stations in Costa Rica during Janury*, 1901.

Stations.	Amount.	Days.	Stations.	Amount.	Days.
	Mm.			Mm.	
1. Boca Banano	265	17	13. Juan Vinas	159	14
2. Limon	304	19	14. Santiago‡	.....	.....
3. Swamp Mouth*	.....	.....	15. Paraiso‡	.....	.....
4. Zent‡	.....	.....	16. San Rafael C†	.....	.....
5. Gute Hoffnung	411	15	17. Tres Rios	2	1
6. Siquirres	406	10	18. La Palma†	.....	.....
7. Guapiles†	.....	.....	19. San Francisco G.	7	2
8. Sarapiqui†	.....	.....	20. San Jose	4	2
9. San Carlos	301	19	21. La Verbena†	.....	.....
10. Las Lomas	521	16	22. Alajuela†	.....	.....
11. Peralta†	.....	.....	23. Nuestro Amo†	.....	.....
12. Turrialba‡	.....	.....			

*Observations not complete. †Observations not received. ‡Observations to begin March 1.

RELATION OF THE WATER LEVEL OF GREAT SALT LAKE TO THE PRECIPITATION.

By L. H. MURDOCH, Section Director, dated January 25, 1901.

On December 31, 1900, the water level of Great Salt Lake was 9 inches below the zero of the scale, measured on the gage at Garfield Beach. This gage was established many years ago by the United States Geological Survey and its zero placed at what was believed to be one foot below the lowest known water. Many old settlers claim, however, that the water was lower in 1848 than the point accepted by the officials of the United States Geological Survey as the lowest known level. In 1848 there was a dry bar extending from the mainland to Antelope Island. In September of 1900 this bar was again exposed, and since then it has been possible to drive or walk to the island dry shod. There can be but little doubt that the reading of minus 9 inches is the lowest water level reached since the settlement of the State.

The question naturally arises, what is the cause of this remarkable fall in the lake and will it continue to fall and finally disappear within a few years?

One explanation offered is that the fall is due to the diverting of large quantities of water from the streams flowing into the lake for irrigation purposes. With a view to ascertaining how far a shortage in precipitation is responsible for this decline in the lake level, all the precipitation data collected in the Great Salt Lake basin was tabulated and the averages calculated and compared. But it was seen that objection could be raised to any conclusions drawn from these averages for the reason that the average annual rainfall of the basin ranges from less than 5 inches in the driest parts to about 18 inches where the precipitation is heaviest, and as stations have been established here and discontinued there, it was seen that the data was not comparable. Nevertheless, the results of these calculations and comparisons show that the last fifteen years have been the driest on record.

The precipitation data for Salt Lake City, including that for Fort Douglas, are complete back to 1863, with the exception of the data for 1866. The data for Ogden and Corinne are complete back to and including 1871. These stations lie a few miles east of the lake, and the distance from Corinne on the north to Salt Lake City on the south is about 55 miles. The data for these stations were tabulated, averages obtained for each year, and the results charted.

The average annual precipitation for these three stations from 1863 to 1900, inclusive, is 14.65 inches. The last decline in the water level of the lake began in 1887. The average precipitation from 1863 to 1885, inclusive, is 15.32 inches, while the average from 1886 to 1900, inclusive (fifteen years), is only 13.67 inches, which is 0.98 inches below the average for all years and 1.65 inches below the average for the pre-

ceding twenty-three years. The year 1886 has been included with those following because it was a decline in the precipitation that year which caused the lake to fall the following year. Of course the average for the entire period gives the best normal, and, as the comparison of the average for the last fifteen years with this normal, shows an average shortage of 0.98 inch for each year, the total shortage for the fifteen years ending 1900 is 14.70 inches. With a shortage of 14.70 inches in rainfall a decided fall in the lake level would naturally be expected, and a fall of about 9 feet and 11 inches occurred. The fall was from a maximum of about 9 feet 2 inches in 1886 to a minimum of minus 9 inches at the close of 1900.

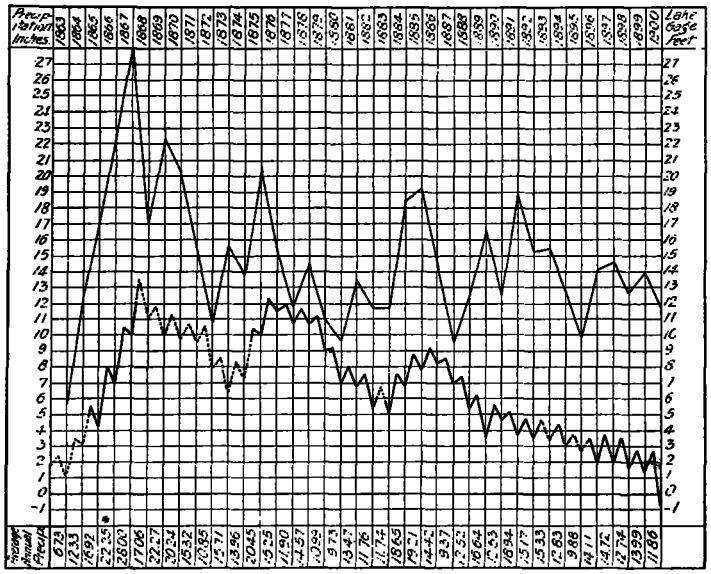

FIG. 2.—Chart showing average annual precipitation of Great Salt Lake basin as obtained from the records of three stations, Salt Lake City, Ogden, and Corinne, and fluctuations of water level of Great Salt Lake from 1863 to 1900.

The upper line indicates the precipitation and the lower one the lake level.

Dotted line indicates periods of no authentic observations or that the data have been approximated.

The lake level from 1863 to 1890 is from a diagram published by the Oregon Short Line Railroad Company, and based upon data furnished by Prof. Marcus E. Jones.

The average precipitation for the fifteen years preceding 1886, or from 1871 to 1885, inclusive, was 14.24 inches, which is 0.57 inch greater than the average for the fifteen years ending 1900, but 0.41 inch below the normal. The average for the eight years from 1863 to 1870, inclusive, approximating the precipitation of 1866 at 22.25 inches, is 18.82 inches, or 3.57 inches above the normal. The wettest fifteen consecutive years were those from 1864 to 1878, inclusive, with an average of 17.14 inches, and during this period the lake rose to a maximum height of about 13 feet 5 inches in 1868, fell to a minimum of about 6 feet in 1874, and reached a maximum height of about 12 feet 5 inches in 1876. The rise of 1868 was preceded by 28 inches of rainfall in 1867, and the rise of 1876 by 20.45 inches in 1875.

The question now arises, is the climate of the Great Salt Lake basin becoming drier?

The climate of the Great Salt Lake basin is not changing. The average precipitation for the next fifty years will agree very closely with the average for the past fifty years. Periods of heavy precipitation will occur again, and following them the lake will rise to about the same levels reached by it in the past.

*Approximated.

THE WATER LEVEL OF GREAT SALT LAKE.

By Mr. G. K. GILBERT, U. S Geological Survey, dated February 8, 1901.

The data Mr. Murdoch has brought together I find interesting, not only because they relate to a subject which occupied my attention some years ago, but because they give an unexpected attestation to the value of the ordinary record of precipitation. For various reasons it has been thought that the rain gage records but imperfectly the actual precipitation of the locality where it is placed, and also that the precipitation record at a single locality in an arid district represents very imperfectly the march, from year to year, of the average precipitation of the surrounding region. Mr. Murdoch's table compares a local precipitation record with the variations of a water surface so situated as to be greatly influenced by variations of the precipitation on a neighboring mountain range, and the accordance of the two records seems to me remarkably good.

Omitting the years for which the lake water record is interpolated, I find from the graphic table that there are twenty-three annual records susceptible of direct comparison with the rain-gage record. For each of these twenty-three years, I have compared the rain-gage record with the normal, noting the excess or defect of precipitation, and I have also compared the records of lake level for the beginning and end of the year, noting whether, and how much, the level has risen or fallen. The correspondence of excess of precipitation with the rise of the lake, and of defect of precipitation with the fall of the lake, is almost complete, there being but three years of the twenty-three in which a deviation of precipitation from the normal to the extent of one inch, is not accompanied by a change of lake level having the proper sign.

Finding the data thus accordant, I have thought it legitimate to carry the discussion a little further than Mr. Murdoch has done. He has shown that the recent great fall of the lake surface corresponds to a period of defective precipitation, but he has not attempted to show whether the change in precipitation is fully adequate to account for the lowering of the lake. Making use of his tables, and neglecting as before, the years for which the lake record is interpolated, I find that there were eight years in which the recorded precipitation exceeded the normal, the total excess amounting to 36.46 inches. In six of those eight years the lake rose 9.9 feet, and in other two it fell 2.8 feet, leaving a net rise of 7.1 feet. In fifteen years the rainfall was less than the normal, giving a total defect of 32.99 inches. In thirteen of those years the lake fell 12.4 feet, and in the other two rose 1.5 feet, leaving a net fall for the period of 10.9 feet. Summing these data, without regard to signs, we have a total of deviations of precipitation from the normal amounting to 69.45 inches, corresponding to a total of accordant changes in the level of the lake amounting to 18.0 feet. This gives 0.26 foot as the amount of lake change corresponding to one inch excess or defect of precipitation, and we may apply this factor to the period of defective rainfall mentioned by Mr. Murdoch. In the fifteen years, from 1886 to 1900, inclusive, the total shortage of rainfall is 14.70 inches, and this, according to the scale just determined, will account for 3.82 feet of fall in the lake. The actual fall was considerably greater, being 9.9 feet.

While this discussion is not fully satisfactory, and is open to the objection that the lake change per unit of precipitation is derived in part from some of the same observations to which it is afterwards applied, it may yet be accepted as indicating that shortage of rainfall does not suffice to account for the whole of the fall of the lake surface.

The problem is complex, and if a complete analysis were possible, it would probably serve to show that a number of factors have conspired to produce the observed shrinkage of the lake. I apprehend that a prominent place among these